In the Claims:

All pending claims are set forth below. Claims that have been changed by this amendment are marked as "amended."

Please cancel claims 1-76 without prejudice.

Please add the following claims:

77. (new) A computer readable medium including program instructions for simulating the spatial interaction of a displayed first simulated object with a displayed second simulated object in a computer-simulated spatial environment such that the user is provided with a force feedback that realistically represents said interaction, said program instructions performing the following on a computer system:

executing a simulation including a first simulated object, said simulation being configured to implement the motion of said first simulated object in response to motion of a physical object of an interface device controlled by a user, wherein said physical object has a physical position in a physical workspace, and wherein a position control mapping between said simulated location of said first simulated object and said physical position of said physical object exists, said simulation being further configured to generate a second simulated object having boundaries such that said second simulated object impedes the simulated motion of said first simulated object when the trajectory of said first simulated object intersects said boundaries of said second simulated object;

providing information causing a display device to display the location and motion of said first simulated object and said second simulated object such that when said first simulated object and second simulated object collide, the first simulated object is displayed at the boundary of the second simulated object as if unable to substantially penetrate said second simulated object, even if the motion of said physical object would indicate that a penetration should occur with respect to the position control mapping; and

providing information causing a force feedback mechanism to impart to a user of said force feedback mechanism a physical sensation that corresponds to the simulated physical

interaction of said first simulated object with said second simulated object when the trajectory of said first simulated object intersects the boundaries of said second simulated object.

78. (new) The computer readable medium of claim 77, wherein said physical sensation includes a restoring force that is proportional to an amount of said penetration of said second simulated object.

79. (new) The computer readable medium of claim 78, wherein said restoring force includes a spring force having the mathematical form:

$$F = kx$$

where F is said restoring force, x is a magnitude of a deviation of said spatial correlation including a deviation between the current location of the first simulated object and a location of said first simulated object had said mapping not been broken, and k is a spring constant parameter.

80. (new) The computer readable medium of claim 79, wherein said restoring force includes a damping force and said restoring force has the mathematical form:

$$F = kx + bv$$

where F is said restoring force, x is a magnitude of a deviation of said spatial correspondence including a deviation between the current location of the first simulated object and a location of said first simulated object had said mapping not been broken, v is a function of a velocity of said physical object, and k and b are constant parameters.

81. (new) The computer readable medium of claim 80, wherein said restoring force includes an intertial force corresponding to the movement of said second simulated object in response to said interaction between said second simulated object and said first simulated object and said restoring force has the mathematical form:

$$F = kx + bv + ma$$

where F is said restoring force, x is a magnitude of a deviation of said spatial correspondence including a deviation between the current location of the first simulated object and a location of said first simulated object had said mapping not been broken, v is a function of

a velocity of said physical object, a is a function of an acceleration of said physical object, and k, b and m are constant parameters.

82. (new) The computer readable medium of claim 78, wherein said restoring force includes a component resulting from friction between said simulated object and said simulated spatial environment.

83. (new) The computer readable medium of claim 78, wherein said second simulated object moves on said display device during said simulation in response to manipulations of a second physical object of a second interface device by said second user, said second interface device being coupled to a second computer system coupled to said computer system through a network interface.

84. (new) The computer readable medium of claim 78, wherein said restoring force includes a weighting factor such that the location L on said display device of the simulated objects shown on said display device is determined by the equation:

$$L = \frac{(w_1 x_1 + w_2 x_2)}{(w_1 + w_2)}.$$

85. (new) The computer readable medium of claim 77, wherein said processor is coupled with a second processor executing said simulation, said second processor being responsive to input from a second interface device, said processors being coupled such that said simulations communicate input information from said interface devices.

86. (new) A method for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a force feedback device coupled to said host computer, the method comprising:

moving a first graphical object in response to movement of a user manipulatable object of said force feedback device by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object;

determining whether said first graphical object has engaged a second graphical object by examining a path of said first graphical object in said graphical environment, said path determined by examining a current location of said first graphical object and a previous location of said first graphical object;

providing an illusion of rigidity of said second graphical object by displaying said first graphical object as remaining engaged with said second graphical object when said path of said first graphical object has been determined to move through said second graphical object according to said movement of said user manipulatable object; and

providing information that causes said force feedback device coupled to said host computer to output an opposing force on said user manipulatable object by at least one actuator in said force feedback device in a direction approximately opposite to said path of said first graphical object while said first graphical object is engaged with said second graphical object.

87. (new) A method as recited in claim 86 wherein said opposing force is a restoring spring force.

88. (new) A method as recited in claim 86 wherein said second graphical object is fixed in location within said graphical environment.

89. (new) A method as recited in claim 86 wherein said user is a first user, and wherein said second graphical object is moveable according to input from a second user of a second force feedback device coupled to said host computer.

90. (new) A method as recited in claim 89 wherein said host computer is a first host computer, and wherein said second force feedback device is coupled to a second host computer which is coupled to said first host computer via a network.

91. (new) A method as recited in claim 90 wherein said network is the World Wide Web.

92. (new) A method as recited in claim 86 wherein a friction force is output on said user manipulatable object when said user manipulatable object is moved in a direction corresponding to a direction approximately perpendicular to said path of engagement of said first graphical object while said first and second graphical objects are engaged.

93. (new) A method as recited in claim 92 wherein said friction force has a magnitude that is a function of said magnitude of said opposing spring force.

94. (new) A method for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a force feedback device coupled to said host computer, the method comprising:

(a) moving a first graphical object in response to movement of a user manipulatable object of said force feedback device by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object;

(b) determining whether said first graphical object has engaged a second graphical object by examining a path of said first graphical object in said graphical environment, said path determined at least in part by examining a previous location of said first graphical object; and

(c) providing information that causes said force feedback device coupled to said host computer to output:

(i) an opposing force on said user manipulatable object by at least one actuator in said force feedback device when said user manipulatable object is moved in a direction approximately opposite to said path of said first graphical object while said first graphical object is engaged with said second graphical object; and

(ii) a friction force on said user manipulatable object by at least one actuator in said force feedback device when said user manipulatable object is moved in a direction corresponding to a direction approximately perpendicular to said path of engagement of said first graphical object while said first and second graphical objects are engaged.

95. (new) A method as recited in claim 94 wherein said opposing force is a spring force, and wherein said friction force has a magnitude that is a function of said magnitude of said opposing spring force.

96. (new) A method as recited in claim 94 further comprising breaking said position control mapping and providing an illusion of rigidity of said second graphical object by displaying said first graphical object as remaining engaged with said second graphical object when said path of said first graphical object has been determined to move through said second graphical object if said position control mapping were maintained.

97. (new) A method for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a tactile feedback device coupled to said host computer, the method comprising:

moving a first graphical object in response to movement of a user manipulatable object of said force feedback device by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object;

determining whether said first graphical object has collided with a second graphical object by examining a path of said first graphical object in said graphical environment;

providing an illusion of rigidity of said second graphical object by displaying said first graphical object as remaining engaged with the surface of said second graphical object when said path of said first graphical object has been determined to move through the surface of said second graphical object according to said movement of said user manipulatable object; and

providing information that causes said tactile feedback device coupled to said host computer to output a sensation felt by said user, produced by at least one actuator in said tactile feedback device, corresponding with the displayed interaction between said first graphical object and said second graphical object.

REMARKS

Claims 77-97 are pending in this application. Claims 1-76 have been cancelled and claims 77-97 have been added by this preliminary amendment. Applicant reserves the right to reintroduce claims of comparable scope to the original claims in a continuation or other related application. Various updates to the specification have also been made.